

REMARKS/ARGUMENTS

Claims 1~12 are withdrawn into a division in Applicant's earlier response for a restriction requirement.

Claims 13~15, 18~25 are remained original as Applicant takes a different position on Examiner's rejection and will described later in detail.

Claims 16&17 were canceled in an earlier amendment.

In Applicant's understanding, though AlGaInP, GaAlInN, InGaAs, ZnSSe are different material used in LED product, there's no obvious difference therebetween when suitable mirror is provided. Basically, reflectivity for respective lighting material and mirror (as listed the attachment) are matchable and thus Applicant believes there's no need to restrict material thereof.

Examiner's rejections under 35 U.S.C. 103(a) have been carefully reviewed, and Applicant wishes to distinguish the present invention from the cited references according to the following analysis:

1. The present invention discloses an LED structure comprising an LED epitaxial structure sequentially comprising a second cladding layer, an active layer, a first cladding layer, a window and a metal contact layer, wherein said second cladding layer is partially exposed; a first electrode formed on said metal contact layer; a second electrode formed on said exposed second cladding layer; a mirror formed beneath said LED epitaxial structure; and a permanent metal substrate plated beneath said mirror.

Please refer to the specification:

page 5, lines 1~3, "a mirror 25 is formed beneath the second cladding layer 11 by means of physical film deposition"; and

page 4, lines 17~21, "The first electrode 31 and the second electrode 32 are respectively formed on the metal contact layer 15 and the exposed second cladding layer 11. The metal contact layer 15 can be further etched to remain only the portion

beneath the first electrode 31, so that the emitted light absorbed by the metal contact layer can be decreased.”

Accordingly, the mirror and the metal substrate of the present invention are formed with non-annealing processes, particularly after the electrodes and the metal contact layer are formed with annealing processes. Therefore, Applicant’s structure can be perfectly preserved through all processes without damage by high-temperature treatments.

The main feature of the present invention is the plated metal substrate, the other features include a mirror beneath the plated substrate, a window and two electrodes on the same side.

2. Chen et al. provides a vertical LED structure with a plated substrate, in which two electrodes are respectively formed above and beneath the semiconductor layer. The copper substrate is plated on the bottom surface of the lower electrode. As shown in Figs. 4~6 and 8, the metallically ohmic electrode (68) is a layer grown or plated all over the layer (66) and sandwiched between the plated substrate (70) and the layer (66). Apparently, Chen et al.’s electrode is totally different from Applicant’s. Further, Chen et al. claims a method for forming a semiconductor device, in which the bonding pad (78) is formed with annealing process after the metallic substrate (70) is plated. Such process will result in damage of the existed structure and seriously reduce yield of the product.

Though Chen et al. also mentioned “multitudes of obverse bonding pads of the metallically ohmic contact are implemented by device manufacture”, however, it seems unclear for one skilled in this art to achieve these bonding pads, for example, to determine positions thereof.

In Chen et al.’s vertical structure, a current-blocking layer (79) inserted in a part of the layer (66) is required to solve the problem of current flowing. However, such blocking layer is unnecessary in Applicant’s LED apparatus.

In Chen et al.’s structure, the n-type AlGaAs layer (62) also serves an optically

transparent window layer, which is apparently different from Applicant's window (14) provided independently.

In Chen et al.'s structure, a mirror between the electrode (68) and the layer (66) is made from a material such as In_2O_3 , SnO_2 , ITO, HfO_2 , MgO , SiO (SiO_2 , SiO_x), TiO (TiO_2 , TiO_x , Ti_2O_3 , Ti_2O_5), ZnO , ZnS , and Al_2O_3 , which is totally different from the material applied to Applicant's mirror.

Further, Chen et al. teach that "The purpose of high-temperature annealing is to provide a good ohmic contact between obverse bonding pad 78 of a metallic ohmic contact and a transparent window layer 62, shown in FIG. 6.", in the specification, column 5, lines 20 ~ 23. However, it's well known to one skilled in the art that the high-temperature annealing process after the mirror or the permanent metal substrate is finished will apparently cause damage thereto. Therefore, yield of product for Chen et al. could not be satisfying as Applicant's.

Also, as described in column 5, lines 10 ~ 11, "...the wafer is reversed upward and downward..." indicates Chen et al. provides an LED structure with layers in order substantially different from Applicant's.

In summary, Chen et al.'s LED apparatus is totally different from Applicant's in many features including positions of the electrodes, bonding pads, current flowing, the window and the mirror.

3. Ishikawa et al., Jou et al. and Yang mentioned LED structures with electrodes on positions similar to Applicant's, or a mirror made from material similar to Applicant's, or a transparent conductive layer similar to Applicant's. However, they have never taught the most important feature of the present invention, a plated substrate.

For example, Ishikawa et al.'s structure shown in Fig. 23 comprises a p-type InGaP contact layer (311) which is made from a material different from Applicant's and arranged on a position different from Applicant's. Applicant believes that Ishikawa et al. determine material and the position of the contact layer (311) according to an LED with stacked RGB active layers, other than an LED with a plated substrate. That is, Ishikawa

et al.'s structure shown in Fig. 23 does not teach or provide an appropriate basis for the present invention.

In addition, as shown in Figs. 6 and 7, a disk-like n-side electrode (125) is required in the lower central part in case of the p-side up structure. Alternatively a current block for uniformly dispersing current should be required in case of the p-side down structure. Such design is obviously complex when compared to Applicant's structure, in which a p-side up electrode is designed on the top of the central part, an n-side electrode is arranged on the exposed cladding layer, and a thick p-GaP window is provided. Therefore, current dispersing could not be a trouble to Applicant's design.

In Applicant's LED apparatus, positions of the electrodes and materials of the active layer and the mirror are determined out of careful consideration for the plated substrate. Applicant believes that the present invention could not be simply made by assembling partial structures from these cited references for a person having ordinary skill in the art.

Applicant also believes that the amendments and remarks/arguments are a complete response to Examiner's rejections/objections, and thus respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

Charles E. Baxley

Charles E. Baxley

90 John Street-Third Floor
New York, N.Y. 10038-3243
U.S.A.